BALLUFF

sensors worldwide

BTL6-A/C/E/G500-M _ _ _ _ -PF-S115

User's Guide

english

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1 Notes to the user

1.1 Validity

This guide describes the construction, function and setup options for the BTL6 Micropulse Transducer with analog interface. It applies to types **BTL6-A/C/E/G500-M _ _ _ _ -PF-S115** (see Ordering code on page 20).

The guide is intended for qualified technical personnel. Read this guide before installing and operating the transducer.

1.2 Symbols and conventions

Individual **handling instructions** are indicated by a preceding triangle.

▶ Action instruction 1

Action sequences are numbered consecutively:

1. Action instruction 1
2. Action instruction 2

i	**Note, tip** This symbol indicates general notes.
ⓐ ⓑ	These symbols indicate the programming inputs.
	Symbols of this type indicate the LED display.

1.3 Scope of delivery

– BTL6 transducer
– Mounting clamps with insulating sleeves and screws
– Condensed guide

i	The magnets are available in various models and must be ordered separately.

1.4 Approvals and markings

c UL us

UL approval
File no.
E227256

US Patent 5 923 164
The US patent was awarded in connection with this product.

CE

The CE Mark verifies that our products meet the requirements of EU Directive 2004/108/EC (EMC Directive).

The transducer meets the requirements of the following generic standards:

– EN 61000-6-1 (noise immunity)
– EN 61000-6-2 (noise immunity)
– EN 61000-6-3 (emission)
– EN 61000-6-4 (emission)

and the following product standard:

– EN 61326-2-3

Emission tests:

– RF emission
  EN 55016-2-3 (industrial and residential areas)

Noise immunity tests:

– Static electricity (ESD)
  EN 61000-4-2 — Severity level 3
– Electromagnetic fields (RFI)
  EN 61000-4-3 — Severity level 3
– Electrical fast transients (burst)
  EN 61000-4-4 — Severity level 3
– Surge
  EN 61000-4-5 — Severity level 2
– Conducted interference induced by high-frequency fields
  EN 61000-4-6 — Severity level 3
– Magnetic fields
  EN 61000-4-8 — Severity level 4

i	More detailed information on the guidelines, approvals, and standards is included in the declaration of conformity.

2 Safety

2.1 Intended use

The BTL6 Micropulse Transducer, together with a machine controller (e.g. PLC), comprises a position measuring system. It is intended to be installed into a machine or system. Flawless function in accordance with the specifications in the technical data is ensured only when using original BALLUFF accessories. Use of any other components will void the warranty.

Opening the transducer or non-approved use are not permitted and will result in the loss of warranty and liability claims against the manufacturer.

2.2 General safety notes for the position measuring system

Installation and **startup** may only be performed by trained specialists with basic electrical knowledge.
Qualified personnel are those who can recognize possible hazards and institute the appropriate safety measures due to their professional training, knowledge, and experience as well as their understanding of the relevant conditions pertaining to the work to be done.

The **operator** is responsible for ensuring that local safety regulations are observed.
In particular, the operator must take steps to ensure that a defect in the position measuring system will not result in hazards to persons or equipment.
If defects and unresolvable faults occur in the transducer, it should be taken out of service and secured against unauthorized use.

2.3 Explanation of the warnings

Always observe the warnings in these instructions and the measures described to avoid hazards.

The warnings used here contain various signal words and are structured as follows:

SIGNAL WORD
Hazard type and source Consequences if not complied with ▶ Measures to avoid hazards

The individual signal words mean:

NOTICE!
Identifies a hazard that could **damage or destroy the product**.
⚠ DANGER
The general warning symbol in conjunction with the signal word DANGER identifies a hazard which, if not avoided, **will certainly result in death or serious injury**.

2.4 Disposal

▶ Observe the national regulations for disposal.

3 Construction and function

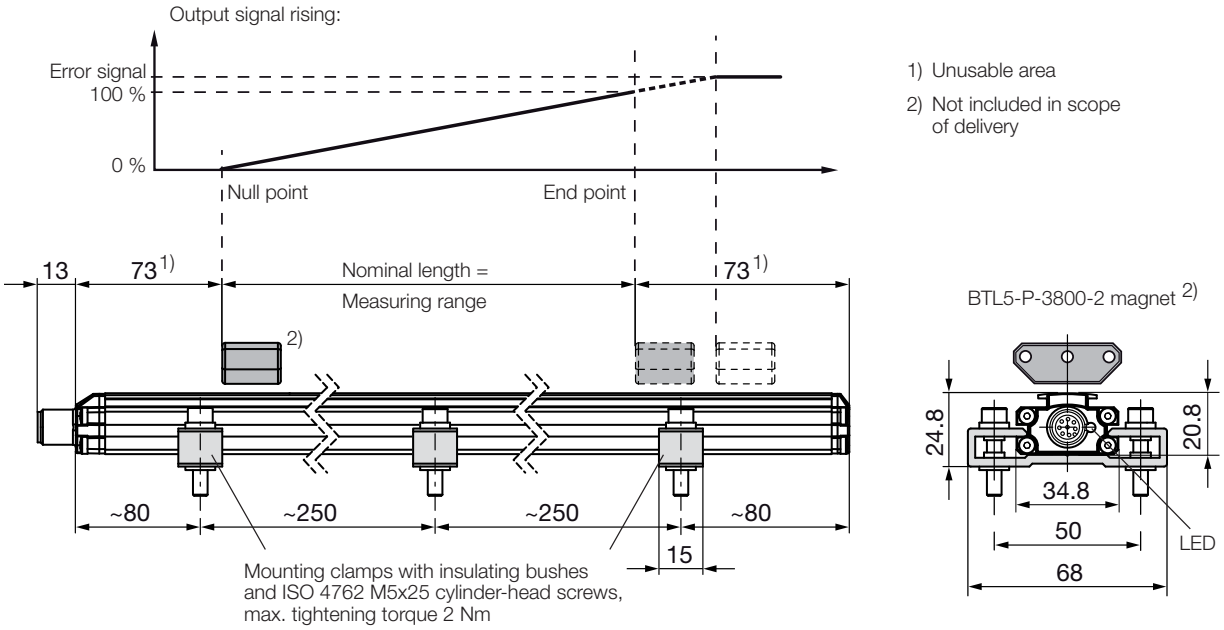


Fig. 2-1: BTL6... transducer, construction

3.1 Construction

Electrical connection: The electrical connection is made via a connector (see ordering code on page 20).

BTL housing: Aluminum housing containing the waveguide and processing electronics.

Magnet: Defines the position to be measured on the waveguide. Magnets are available in various models and must be ordered separately (see accessories on page 18).

Nominal length: To optimally adapt the transducer to the application, the following nominal lengths are available:

Nominal length	Grading
50 to 4572 mm	25 mm

3.2 Function

The BTL6 transducer contains the waveguide which is protected by an aluminum housing. A magnet is moved along the waveguide. This magnet is connected to the system part whose position is to be determined.

The magnet defines the position to be measured on the waveguide.

An internally generated INIT pulse interacts with the magnetic field of the magnet to generate a torsional wave in the waveguide which propagates at ultrasonic speed.

The component of the torsional wave which arrives at the end of the waveguide is absorbed in the damping zone to prevent reflection. The component of the torsional wave which arrives at the beginning of the waveguide is converted by a coil into an electrical signal. The travel time of the wave is used to calculate the position. Depending on the version, this information is made available as a voltage or current output with a rising gradient.

3.3 LED display

In normal operation the LED indicates the operating states of the transducer.

LED	Operating state
Green	**Normal function** Magnet is within the measuring range.
Flashing red	**Measuring range left** Magnet is outside the measuring range.
Red	**Error** No magnet or magnet outside the limits.

4 Installation and connection

4.1 Installing the transducer

NOTICE!

Improper installation

Improper installation can compromise the function of the transducer and result in damage.

- For this reason, ensure that no strong electrical or magnetic fields are present in the immediate vicinity of the transducer.
- The recommended spacing for the installation must be strictly observed.

Any orientation is permitted. Mount the transducer on a level surface of the machine using the provided mounting clamps and cylinder-head screws. A sufficient number of mounting clamps is supplied.

i In order to avoid the development of resonant frequencies from vibration loads, we recommend arranging the mounting clamps at irregular intervals.

The transducer is electrically isolated from the machine with the supplied insulating bushes (see Figure 3-1).

1. Guide the transducer into the mounting clamps.
2. Attach transducer to the base using mounting screws (tighten screws in the clamps with a max. 2 Nm).
3. Insert magnet (accessories).

i The micropulse transducer in profile housing is suitable both for floating, i.e. non-contacting magnets (see Figures 4-3 to 4-7) and for captive magnets (see Figures 4-1 and 4-2).

4.2 Captive magnets

The following must be observed when installing the magnet:

– Avoid lateral forces.
– Connect the magnet to the machine member with a joint rod (see Accessories on page 19).

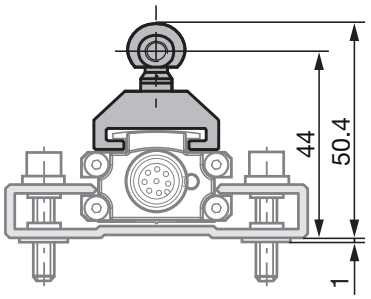


Fig. 4-1: Dimensions and distances with BTL5-F-2814-1S magnet

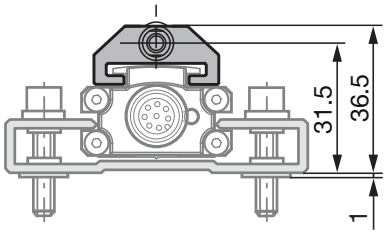


Fig. 4-2: Dimensions and distances with BTL5-T-2814-1S magnet

4 Installation and connection (continued)

4.3 Floating magnets

The following must be observed when installing the magnet:

- To ensure the accuracy of the position measuring system, the magnet is attached to the moving member of the machine using non-magnetizable screws (stainless steel, brass, aluminum).
- The moving member must guide the magnet on a track parallel to the transducer.
- Ensure that the distance A between parts made of magnetizable material and the magnet is at least 10 mm (see Figures 4-3 to 4-7).
- Maintain the following values for distance B between the magnet and transducer and for center offset C (see Figures 4-3 to 4-7):

Type of magnet	Distance B	Offset C
BTL5-P-3800-2	0.1 to 4 mm	± 2 mm
BTL5-P-5500-2	5 to 15 mm	± 15 mm
BTL5-P-4500-1	0.1 to 2 mm	± 2 mm
BTL6-A-3800-2	4 to 8 mm[1)]	± 2 mm
BTL6-A-3801-2	4 to 8 mm[1)]	± 2 mm

[1)] For optimum measurement results, a distance B of 6 to 8 mm is recommended.

Tab. 4-1: Distance and offset for magnets (see Figures 4-3 to 4-7)

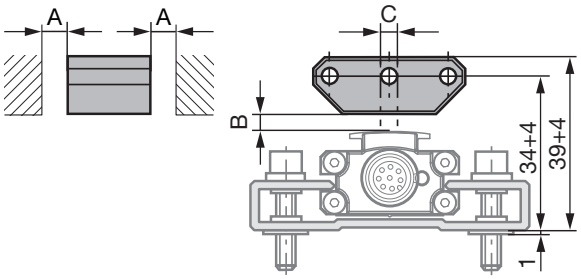


Fig. 4-3: Dimensions and distances with BTL5-P-3800-2 magnet

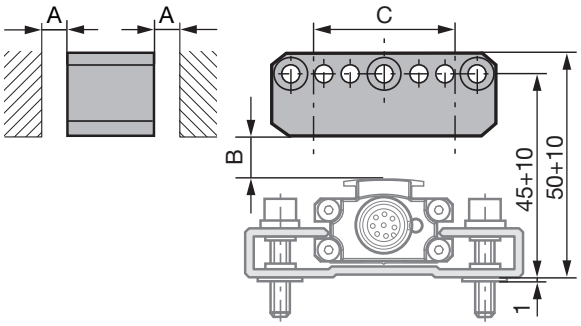


Fig. 4-4: Dimensions and distances with BTL5-P-5500-2 magnet

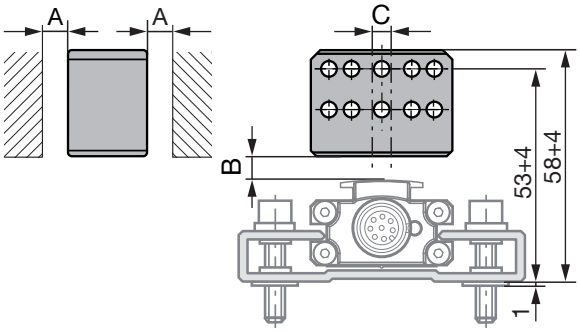


Fig. 4-5: Dimensions and distances with BTL6-A-3800-2 magnet

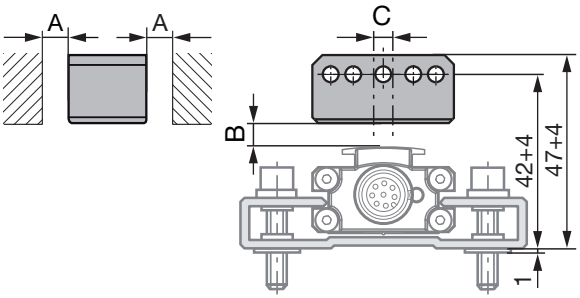


Fig. 4-6: Dimensions and distances with BTL6-A-3801-2 magnet

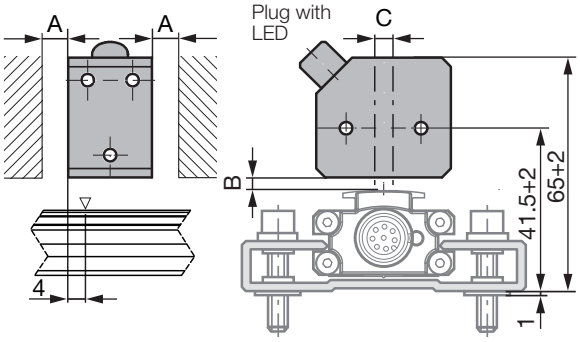


Fig. 4-7: Dimensions and distances with BTL5-P-4500-1 electromagnet (24 V/100 mA)

The measuring range is offset by 4 mm towards the BTL plug (see Figure 4-7).

4 Installation and connection (continued)

4.4 Electrical connection

Pin	BKS-S115-... BKS-S116-...	-A500	-G500	-C500	-E500
1	Yellow	Not used[1]			
2	Gray	0 V			
3	Pink	Not used[1]			
4	Red	La (programming input)			
5	Green	0 to 10 V	–10 to 10 V	0.1 to 20 mA	4 to 20 mA
6	Blue	GND[2]			
7	Brown	10 to 30 V			
8	White	Lb (programming input)			

[1] Unassigned leads can be connected to the GND on the controller side but not to the shield.

[2] Reference potential for supply voltage and EMC-GND.

Tab. 4-2: Pin assignment of S115 connector

Fig. 4-8: Pin assignment of S115 connector (view of connector pins of transducer)

4.5 Shielding and cable routing

Defined ground!
The transducer and the control cabinet must be at the same ground potential.

Shielding
To ensure electromagnetic compatibility (EMC), observe the following:

– Connect transducer and controller using a shielded cable.
  Shield: Braided copper shield with minimum 85% coverage.
– Shield is internally connected to connector housing.

Magnetic fields
The position measuring system is a magnetostrictive system.
It is important to maintain adequate distance between the transducer and strong, external magnetic fields.

Cable routing
Do not route the cable between the transducer, controller, and power supply near high voltage cables (inductive stray noise is possible).

Inductive stray noise from AC harmonics (e.g. from phase angle controls) are especially critical and the cable shield offers very little protection against this.

Cable length
Cable length max. 20 m. Longer cables may be used if their construction, shielding and routing prevent noise interference.

Noise elimination
To avoid equipotential bonding - a current flow - through the cable shield, please note the following:

– Use insulating bushes
– Put the control cabinet and the system in which the BTL6 is located to the same ground potential.

5 Startup

5.1 Starting up the system

⚠ DANGER

Uncontrolled system movement

When starting up, if the position measuring system is part of a closed loop system whose parameters have not yet been set, the system may perform uncontrolled movements. This could result in personal injury and equipment damage.

- ▶ Persons must keep away from the system's hazardous zones.
- ▶ Startup must be performed only by trained technical personnel.
- ▶ Observe the safety instructions of the equipment or system manufacturer.

1. Check connections for tightness and correct polarity. Replace damaged connections.
2. Turn on the system.
3. Check measured values and adjustable parameters and readjust the transducer, if necessary.

i Check for the correct values at the null point and end point, especially after replacing the transducer or after repair by the manufacturer.

5.2 Operating notes

– Check the function of the transducer and all associated components on a regular basis.
– Take the position measuring system out of operation whenever there is a malfunction.
– Secure the system against unauthorized use.

6 Calibration procedure

Output gradient	Linear transducer	Unit	Min. value	Null value	End value	Max. value	Error value
Rising (factory setting)	BTL6-A…	V	–0.5	0	+10.0	+10.5	+10.5
	BTL6-G…	V	–10.5	–10.0	+10.0	+10.5	+10.5
	BTL6-C…	mA	0.1	0.1	20.0	20.4	20.4
	BTL6-E…	mA	3.6	4.0	20.0	20.4	3.6
Falling (after inverting)	BTL6-A…	V	+10.5	+10.0	0	–0.5	+10.5
	BTL6-G…	V	+10.5	+10.0	–10.0	–10.5	+10.5
	BTL6-C…	mA	20.4	20.0	0.1	0.1	20.4
	BTL6-E…	mA	20.4	20.0	4.0	3.6	3.6

Tab. 6-1: Value table for factory settings

6.1 Programming inputs

Programming inputs La and Lb must be used in order to make settings. A programming input at 10 to 30 V corresponds to activation (high active).
The Balluff BTL7-A-CB02-S115 adjusting box can be used for this (see Accessories on page 19).

Automatic deactivation!
If no signals are transmitted via the programming inputs for approx. 10 min, programming mode is automatically ended.

6.2 Calibration procedure notes

Prerequisites

- Programming inputs are connected.
- The transducer is connected to the system controller.
- Voltage or current values from the transducer can be read (using a multimeter, the system control or the adjusting box).

Values for null and end point

- Any desired position of the magnet can be used as the null or end point. However, the null and end points may not be reversed.
- The absolute null and end points must lie within the minimum or maximum limits of what can be output (see value table).

The last set values are always saved, regardless of whether the setting was ended using the programming inputs or automatically after 10 min have expired.

Value table for teach-in and inverting

The following examples refer to transducers with 0 to 10 V or 4 to 20 mA output.

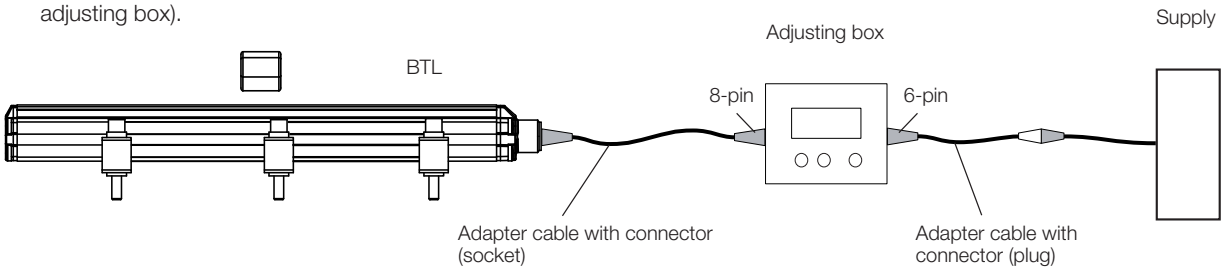


Fig. 6-1: Connecting the BTL7-A-CB02-S115 adjusting box

6 Calibration procedure (continued)

6.3 Calibration procedure overview

6.3.1 Teach-in

The factory set null point and end point is replaced by a new null point and end point. The null point and end point can be set separately, the output gradient changes.

The detailed procedure for teach-in is described on page 14.

Steps

- ▶ Move magnet to the new null position.
- ▶ Read new null point by activating the programming inputs.
  ⇒ The current end point remains the same.

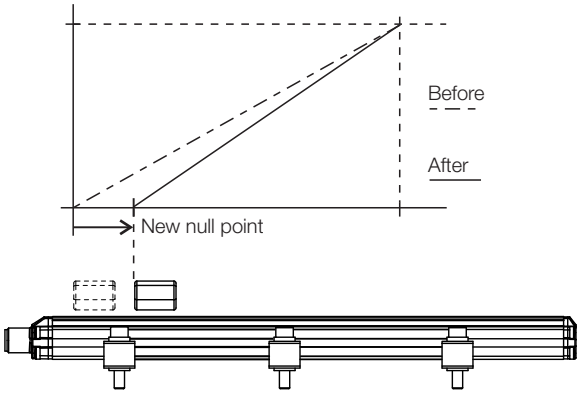


Fig. 6-2: Reading new null point

- ▶ Move magnet to the new end position.
- ▶ Read new end point by activating the programming inputs.
  ⇒ The current null point remains the same.

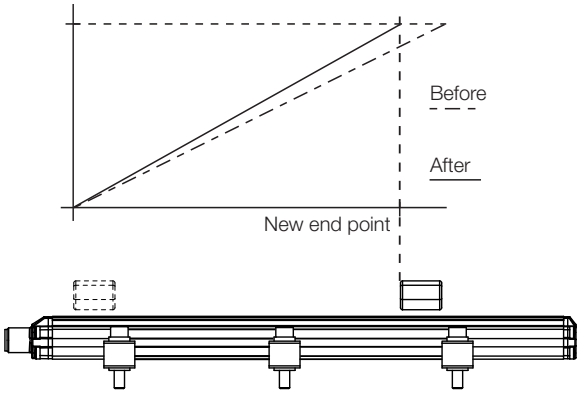


Fig. 6-3: Reading new end point

6.3.2 Inverting

The gradient can be inverted by activating the programming inputs.
During inverting, the output gradient is inverted. For example, a rising output gradient is changed to a falling gradient.

The detailed procedure for inverting is described on page 15.

6.3.3 Reset

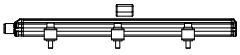
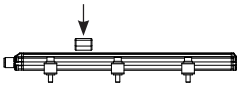
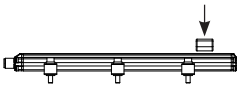
Restoring the transducer to its factory settings.

The detailed procedure for the reset is described on page 16.

7 Teach-in

NOTICE!

Interference in function
Teach-in while the system is running may result in malfunctions.
▶ Stop the system before performing teach-in.

		LED display	Displayed values (example)	
		LED	At 0 to 10 V	At 4 to 20 mA
Initial situation: – Transducer with magnet within measuring range			5.39 V	23.7 mA
1. Activate teach-in ▶ Activate ⓐ for at least 4 s.	> 4 s ⓐ		5.39 V	23.7 mA
2. Set null point ▶ Bring magnet to the new null point. ▶ Activate ⓐ for at least 2 s.	 > 2 s ⓐ		1.04 V	4.82 mA
⇒ The new null point is set after activation.			0.00 V	4.00 mA
3. Set end point ▶ Bring magnet to the new end point. ▶ Activate ⓑ for at least 2 s.	 > 2 s ⓑ		9.89 V	19.13 mA
⇒ The new end point is set after activation.			10.00 V	20.00 mA
4. End teach-in ▶ Briefly activate ⓐ and ⓑ simultaneously (< 1 s).	< 1 s ⓐ + ⓑ			
⇒ Current position value is displayed.				

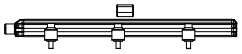
i Any of the individual steps for settings can be selected. The teach-in process can be ended at any time.

LED legend: LED green; LED flashing green; LED red

8 Inverting

NOTICE!

Interference in function
Inverting while the system is running may result in malfunctions.
▶ Stop the system before inverting.

		LED display	Displayed values (example)	
		LED	At 0 to 10 V	At 4 to 20 mA
Initial situation: – Transducer with magnet within measuring range			5.39 V	23.7 mA
1. Activate inverting ▶ Activate ⓑ for at least 4 s.	> 4 s ⓑ		5.39 V	23.7 mA
2. Invert gradient ▶ Activate ⓐ and ⓑ simultaneously for at least 4 s.	> 4 s ⓐ + ⓑ			
After activation: ⇒ The output gradient is inverted. ⇒ Current position value is displayed. ⇒ Inverting is deactivated.			5.61 V	14.85 mA
3. Abort inverting ℹ Inverting can be aborted without any changes being saved after the *Activate inverting* step. ▶ Briefly activate ⓐ and ⓑ simultaneously (< 1 s). ⇒ Current position value is displayed.	< 1 s ⓐ + ⓑ			

LED legend: LED green; LED flashing green; LED red

9 Resetting all values (reset)

NOTICE!

Interference in function

Resetting the values while the system is running may result in malfunctions.

▶ Stop the system before performing the reset.

The reset function can be used to restore all the settings to the factory settings. For a reset the magnet may also be located outside the measuring range.

LED display

LED

1. Activate reset

▶ Simultaneously activate ⓐ and ⓑ for at least 4 s. > 4 s ⓐ + ⓑ

2. Reset

▶ Simultaneously activate ⓐ and ⓑ for at least 4 s. > 4 s ⓐ + ⓑ

After activation:

⇒ All values are reset.

⇒ Current position value is displayed.

⇒ Reset is deactivated.

3. Abort reset

ⓘ Resetting can be aborted without any changes being saved after the *Activate reset* step.

▶ Briefly activate ⓐ and ⓑ simultaneously (< 1 s). < 1 s ⓐ + ⓑ

⇒ Current position value is displayed.

LED legend: LED green; LED flashing green; LED red

10 Technical data

10.1 Accuracy

The specifications are typical values for BTL6-A/C/E/G... at 24 V DC and room temperature, with a nominal length of 500 mm in conjunction with the BTL5-P-3800-2, BTL5-P-4500-1, BTL5-P-5500-2, BTL6-A-3800-2, BTL6-A-3801-2, BTL5-F-2814-1S or BTL5-T-2814-1S magnet.
The BTL is fully operational immediately, with full accuracy after warm-up.

> For special versions, other technical data may apply.
> Special versions are indicated by the suffix -SA on the part label.

Resolution	
BTL6-A/G...	350 µV ≥ 5 µm
BTL6-C/E...	700 nA ≥ 5 µm
Repeat accuracy	≤ ±0.002 % FS ≥ ±5 µm
Sampling rate (dependent on the nominal length)	Max. 2 kHz
Non-linearity at Nominal length ≤ 500 mm Nominal length > 500 mm	 ±200 µm ±0.04 % FS
Temperature coefficient (nominal length = 500 mm, magnet in the middle of the measuring range)	≤ 30 ppm/K
Max. detectable speed	10 m/s

10.2 Ambient conditions

Operating temperature	–25°C to +70°C
Storage temperature	–40°C to +100°C
Relative humidity	< 90%, non-condensing
Shock rating per EN 60068-2-27[1)]	50 g/6 ms
Continuous shock per EN 60068-2-29[1)]	50 g/2 ms
Vibration per EN 60068-2-6[1)]	12 g, 10 to 2000 Hz
Degree of protection per IEC 60529 (when attached)	IP67

[1)] Individual specifications as per Balluff factory standard

10.3 Supply voltage (external)

Voltage, stabilized	10 to 30 V DC
Ripple	≤ 0.5 V_{PP}
Current draw (at 24 V DC)	≤ 150 mA
Inrush current	≤ 3 A/0.5 ms
Reverse polarity protection	Up to 36 V
Overvoltage protection	Up to 36 V
Dielectric strength (GND to housing)	500 V DC

10.4 Output

BTL6-A… Output voltage Load current	0 to 10 V Max. 5 mA
BTL6-C… Output current Load resistance	0.1 to 20 mA ≤ 500 ohms
BTL6-E… Output current Load resistance	4 to 20 mA ≤ 500 ohms
BTL6-G… Output voltage Load current	–10 to 10 V Max. 5 mA
Short circuit resistance	Signal cable to 36 V Signal cable to GND

10.5 Input

Programming inputs La/Lb	10 to 30 V DC High-active
Overvoltage protection	Up to 36 V

10.6 Dimensions, weights

Housing height	20.8 mm
Nominal length	50 to 4572 mm
Weight (depends on length)	Approx. 1 kg/m
Housing material	Anodized aluminum

11 Accessories

11.1 Magnet

BTL5-P-3800-2

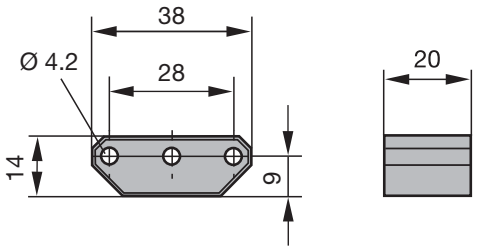


Fig. 11-1: Installation dimensions of BTL5-P-3800-2 magnet

Weight: Approx. 12 g
Housing: Plastic

BTL5-P-5500-2

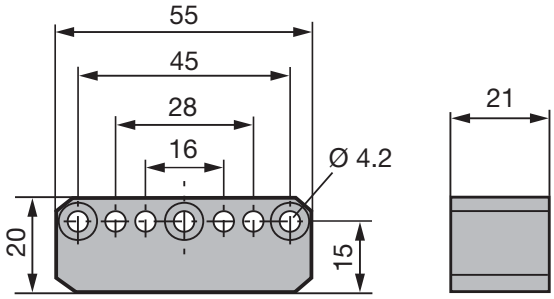


Fig. 11-2: Installation dimensions of BTL5-P-5500-2 magnet

Weight: Approx. 40 g
Housing: Plastic

BTL6-A-3800-2

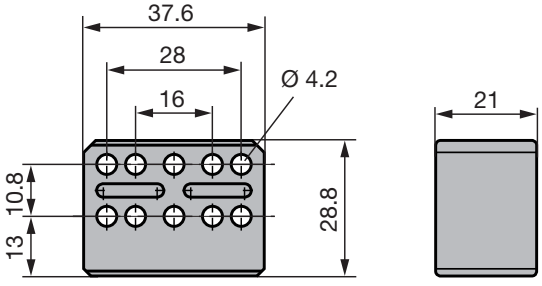


Fig. 11-3: Installation dimensions of BTL6-A-3800-2 magnet

Weight: Approx. 30 g
Housing: Plastic

BTL6-A-3801-2

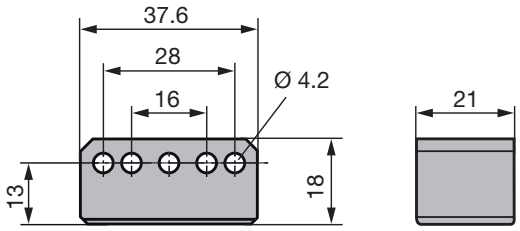


Fig. 11-4: Installation dimensions of BTL6-A-3801-2 magnet

Weight: Approx. 25 g
Housing: Plastic

BTL5-F-2814-1S

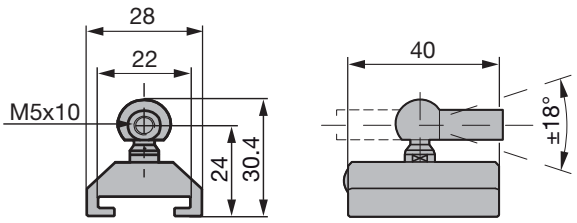


Fig. 11-5: Installation dimensions of BTL5-F-2814-1S magnet

Weight: Approx. 28 g
Housing: Anodized aluminum
Slide surface: Plastic

BTL5-T-2814-1S

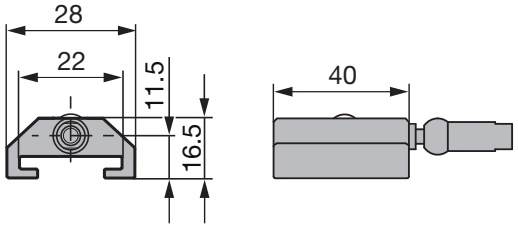


Fig. 11-6: Installation dimensions of BTL5-T-2814-1S magnet

Weight: Approx. 28 g
Housing: Anodized aluminum
Slide surface: Plastic

11 Accessories (continued)

BTL5-P-4500-1

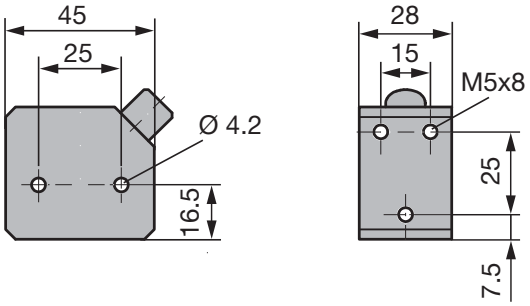


Fig. 11-7: Installation dimensions of BTL5-P-4500-1 magnet

Weight:	Approx. 90 g
Housing:	Plastic
Operating temperature:	–40°C to +60°C

11.2 BTL2-GS10-_ _ _ _-A joint rod

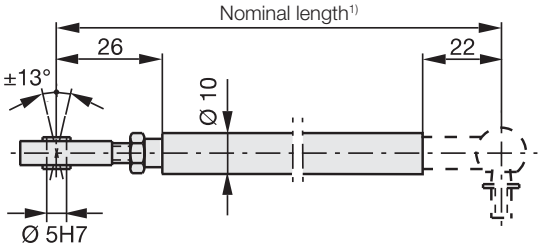


Fig. 11-8: BTL2-GS10-_ _ _ _-A joint rod

Weight:	Approx. 150 g/m
Material:	Aluminum

1) State the nominal length when ordering

11.3 Connector

For information on pin assignment, see Table 4-2 on page 10.

BKS-S115-PU-_ _
Straight connector, molded-on cable, preassembled
M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S115-PU-05: Cable length 5 m

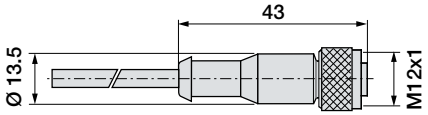


Fig. 11-9: Connector type BKS-S115-PU-_ _

BKS-S116-PU-_ _
Angled connector, molded-on cable, preassembled
M12, 8-pin
Various cable lengths can be ordered, e.g.
BKS-S116-PU-05: Cable length 5 m

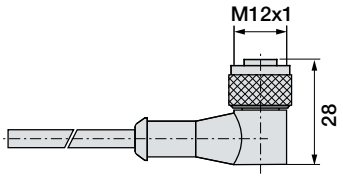


Fig. 11-10: Connector type BKS-S116-PU-_ _

11.4 Adjusting box

BTL7-A-CB02-S115

Scope of delivery:
- Adjusting box
- 2 adapter cables, each approx. 0.3 m
- Condensed guide

12 Ordering code

BTL6 - A 5 00 - M0500 - PF - S115

Micropulse transducer

Interface:
- A = Analog interface, voltage output 0 to 10 V
- G = Analog interface, voltage output –10 to 10 V
- C = Analog interface, current output 0.1 to 20 mA
- E = Analog interface, current output 4 to 20 mA

Supply voltage:
- 5 = 10 to 30 V DC

Output gradient:
- 00 = Rising (factory setting)

Nominal stroke (4-digit):
- M0500 = Metric specification in mm, nominal length 500 mm

Construction:
- PF = flat profile housing

Electrical connection:
- S115 = 8-pin, M12 plug

13 Appendix

13.1 Converting units of length

1 mm = 0.0393700787 inch

mm	inches
1	0.03937008
2	0.07874016
3	0.11811024
4	0.15748031
5	0.19685039
6	0.23622047
7	0.27559055
8	0.31496063
9	0.35433071
10	0.393700787

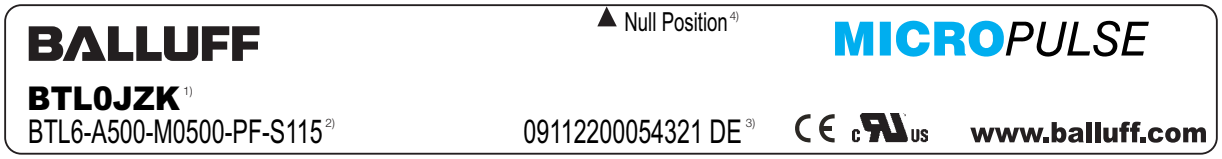
Tab. 13-1: Conversion table mm to inches

1 inch = 25.4 mm

inches	mm
1	25.4
2	50.8
3	76.2
4	101.6
5	127
6	152.4
7	177.8
8	203.2
9	228.6
10	254

Tab. 13-2: Conversion table inches to mm

13.2 Part label



1) Ordering code
2) Type
3) Serial number
4) Null mark

Fig. 13-1: BTL6 part label

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